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(54) **RETRACTABLE TROLLING MOTOR**

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(51) **Int. Cl.**[7] **B63H 20/08**

(52) **U.S. Cl.** **440/53**; 440/6

(58) **Field of Search** .... 440/6, 7, 53; 114/144 E, 114/144 B

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(57) **ABSTRACT**

A propulsion system for a watercraft is provided, which may be an integral part of a watercraft or may be retrofitted to a particular watercraft. The propulsion system is mounted to the hull in a central area, such as forward of a transverse centerline of the hull. The propulsion system includes a propulsion assembly coupled to a retractable arm, which is pivotable between a stowed and operational position. In the stowed position at least a portion of the propulsion assembly may be received within a recessional housing formed in the hull.

27 Claims, 4 Drawing Sheets

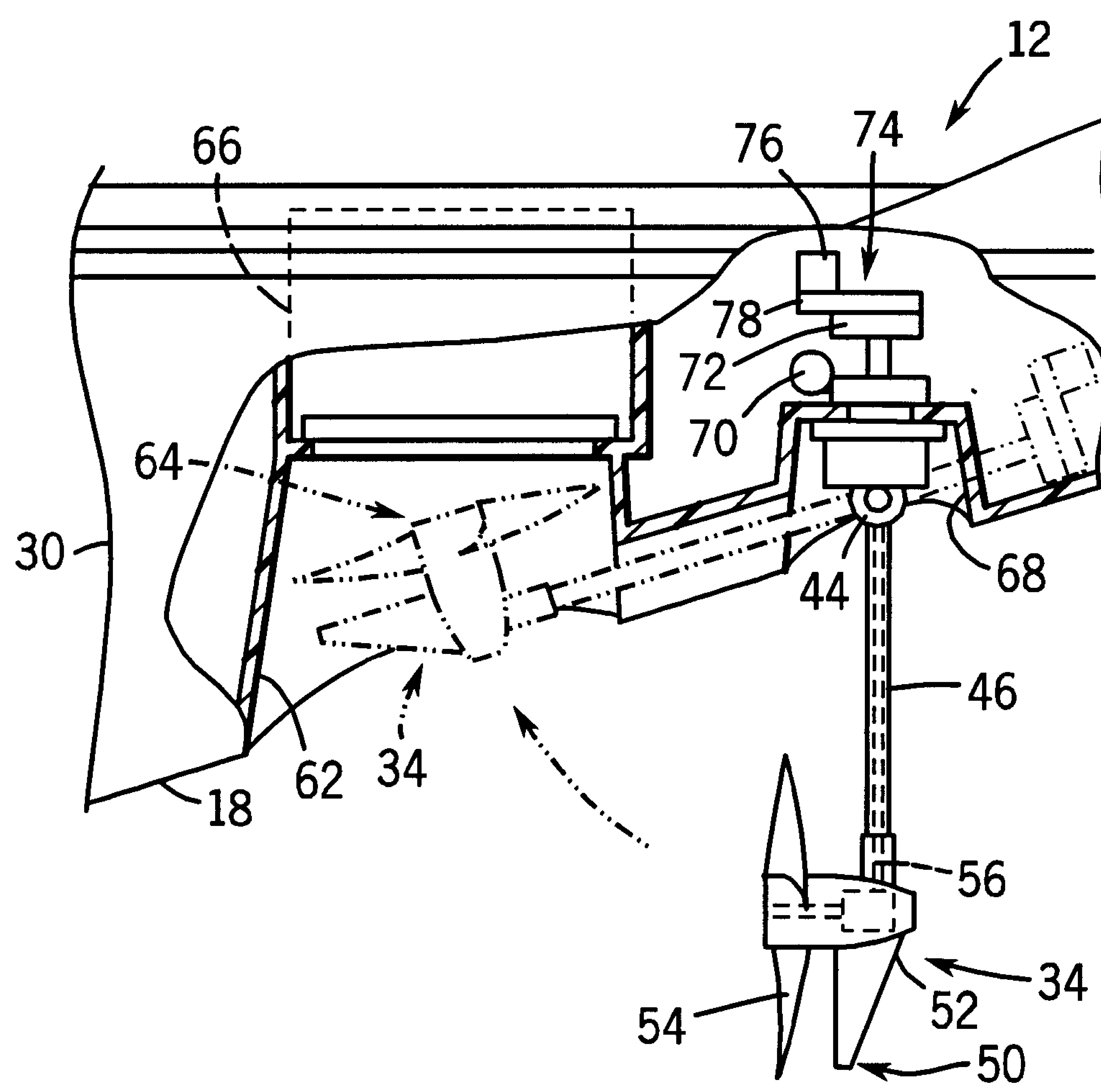


FIG. 1

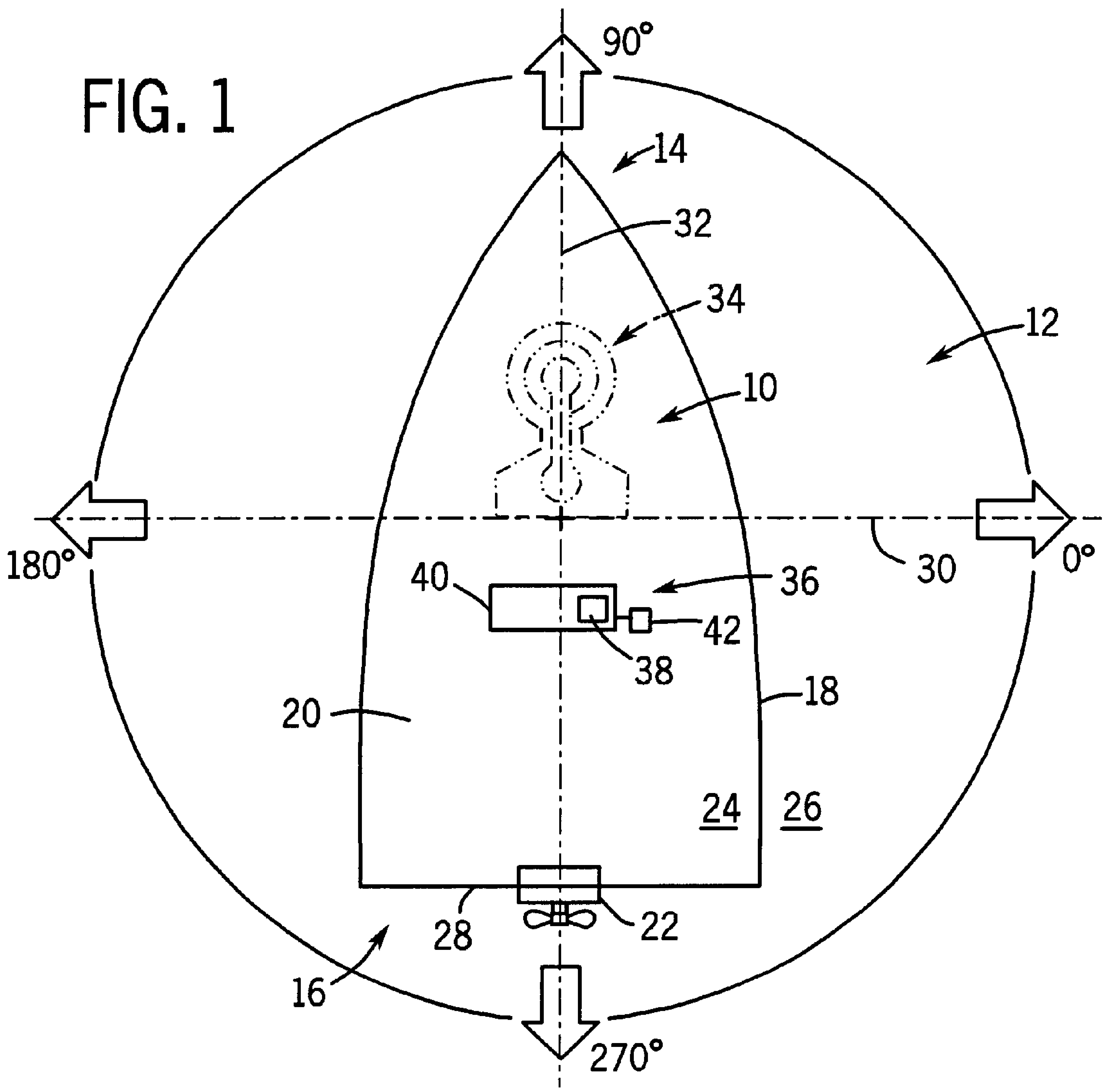


FIG. 2

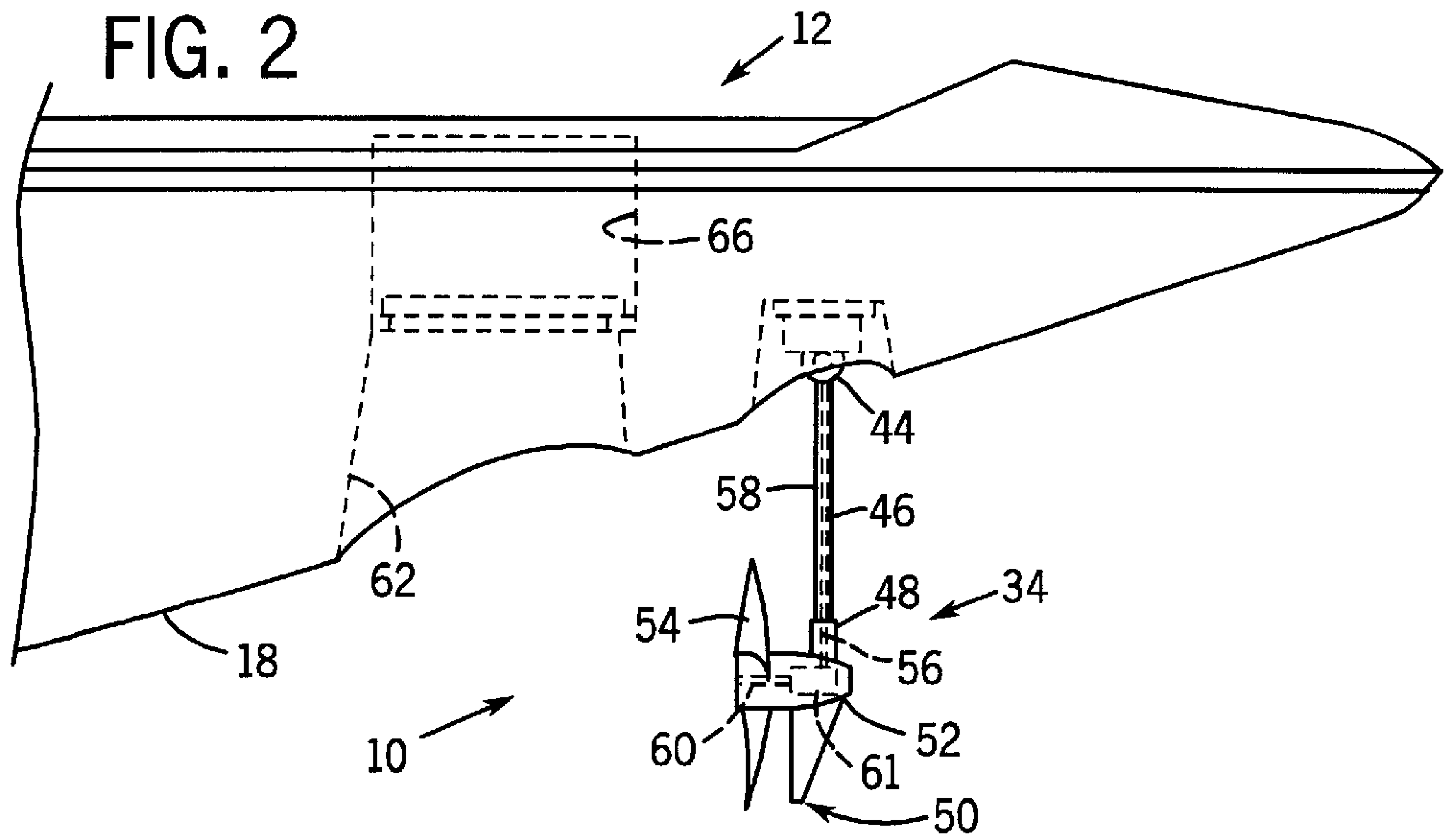


FIG. 3

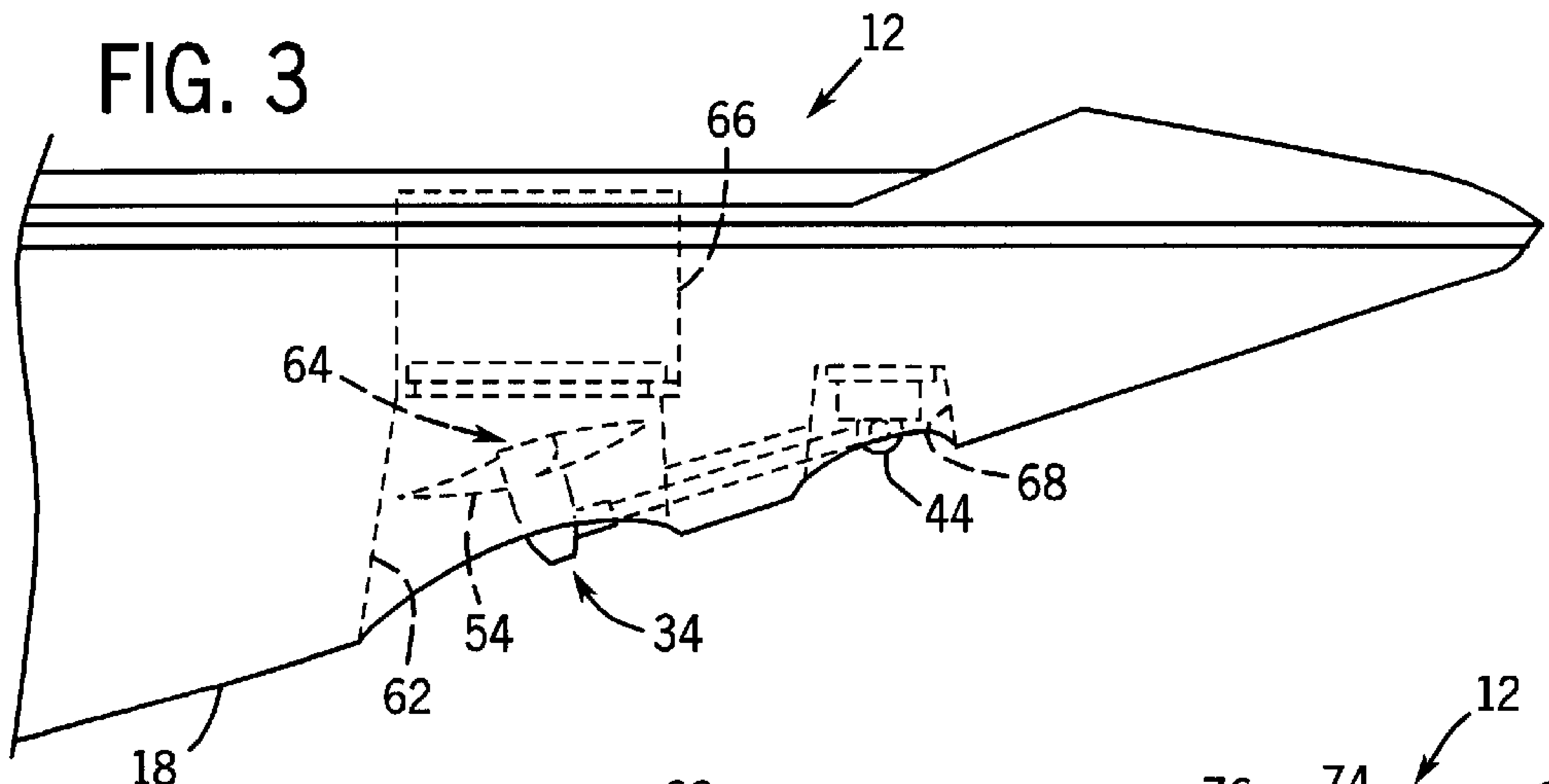
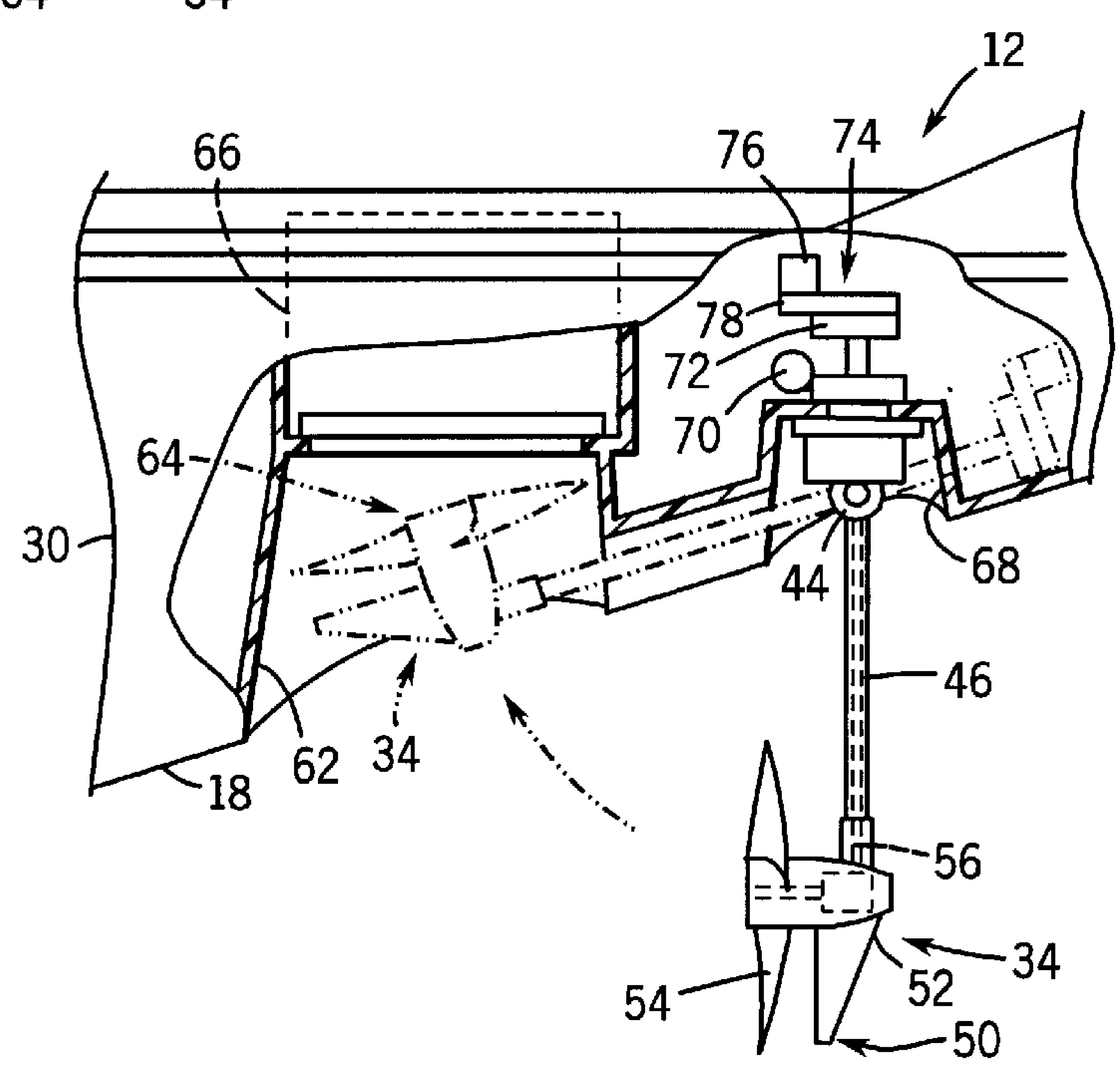


FIG. 4



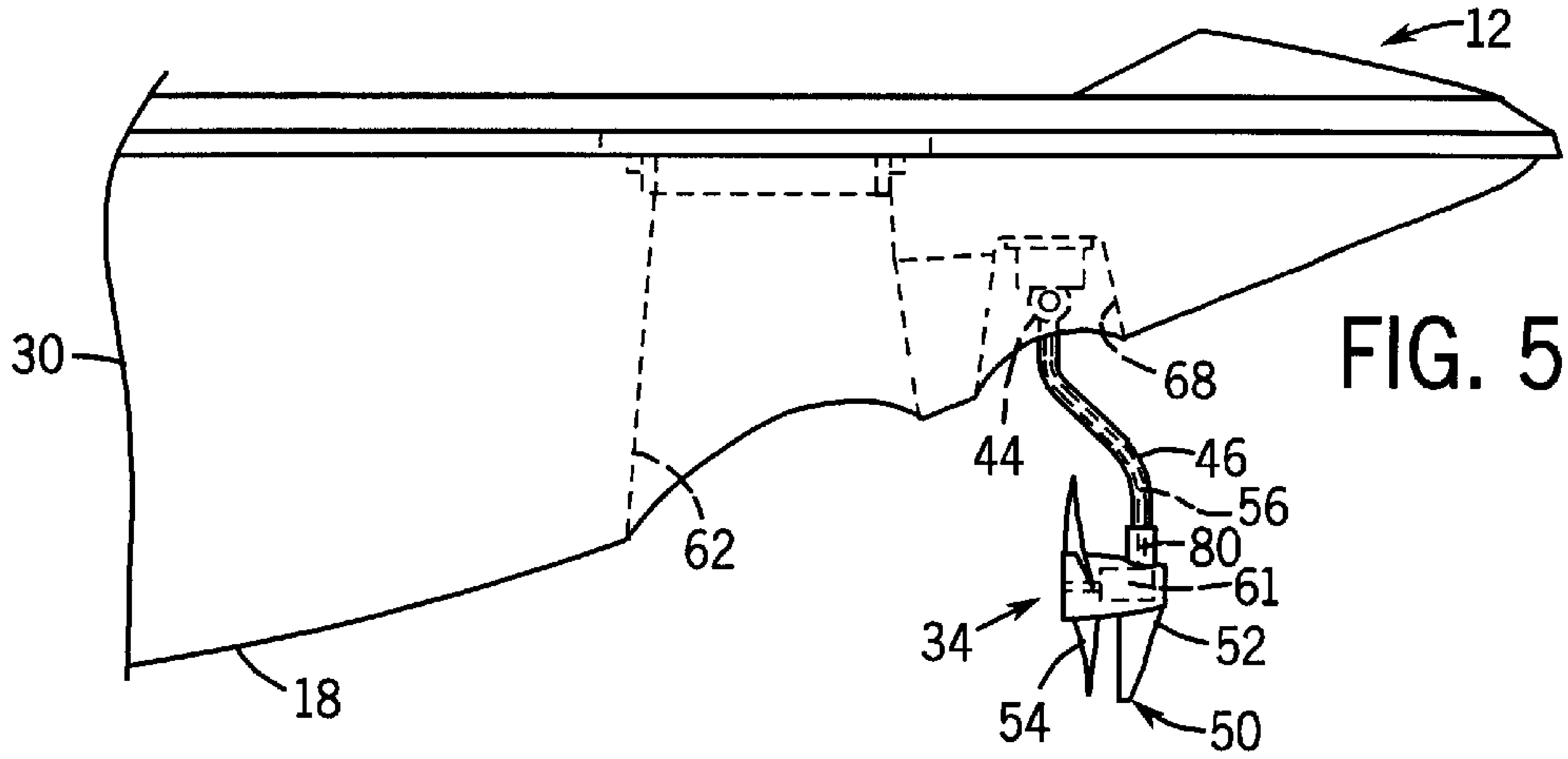


FIG. 5

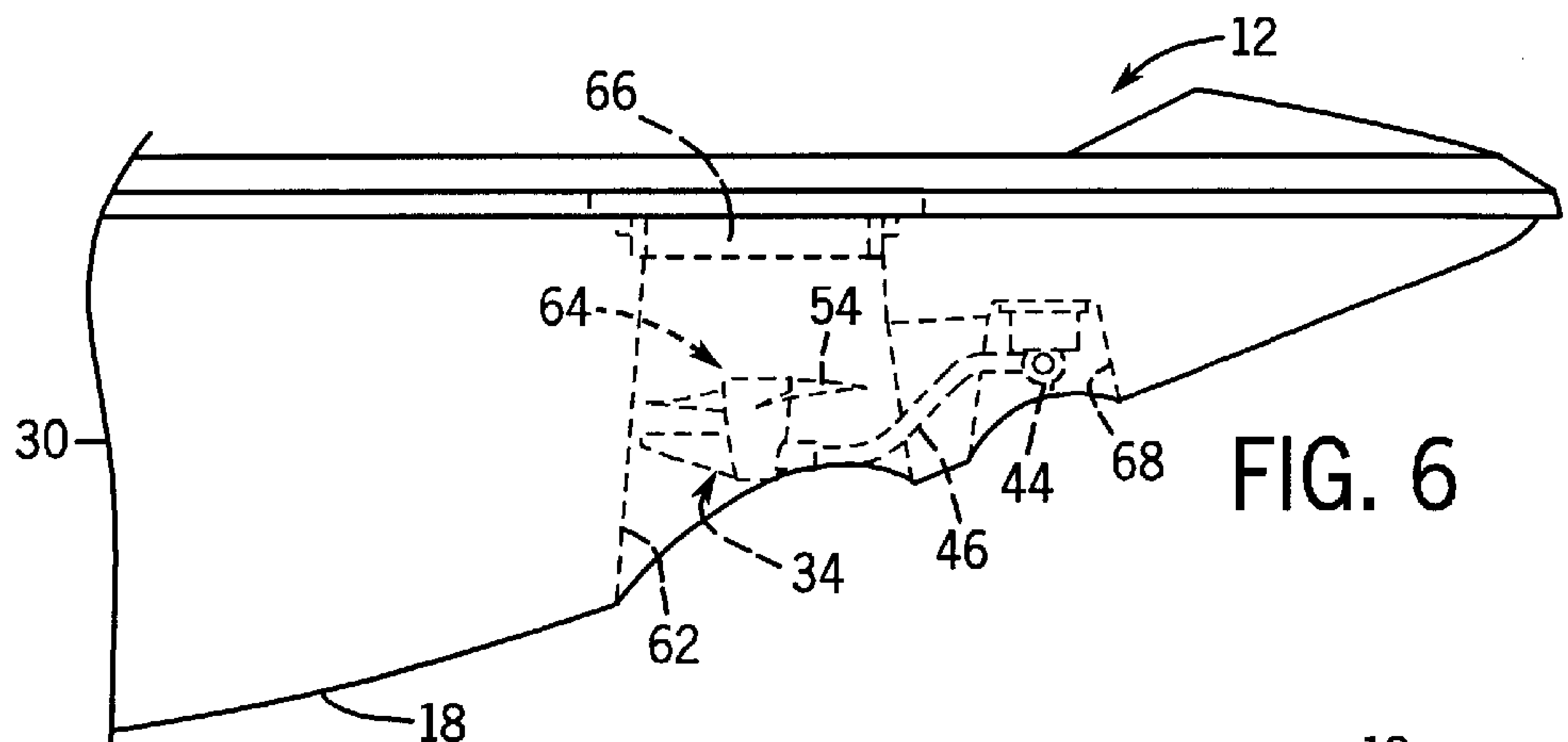


FIG. 6

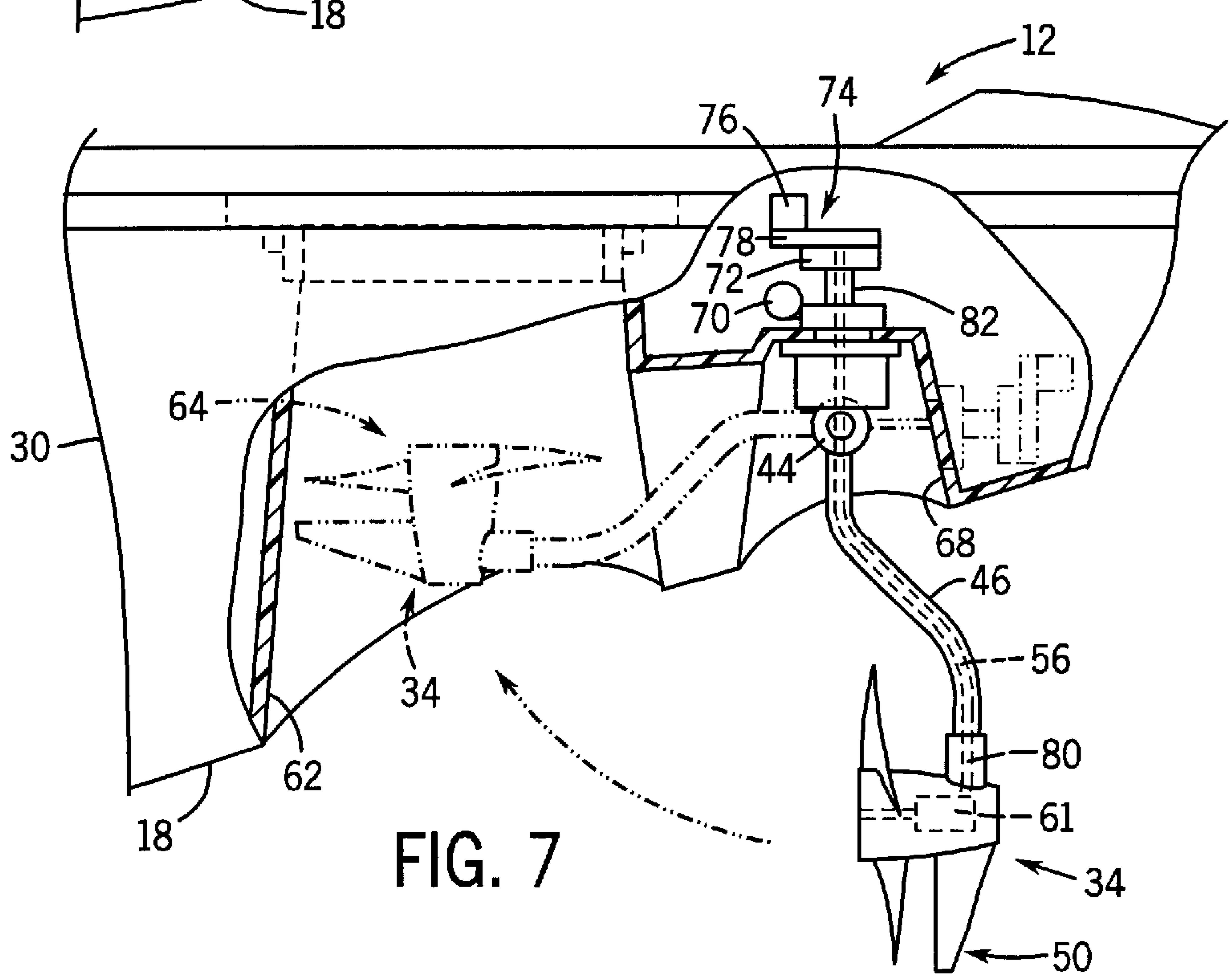


FIG. 7

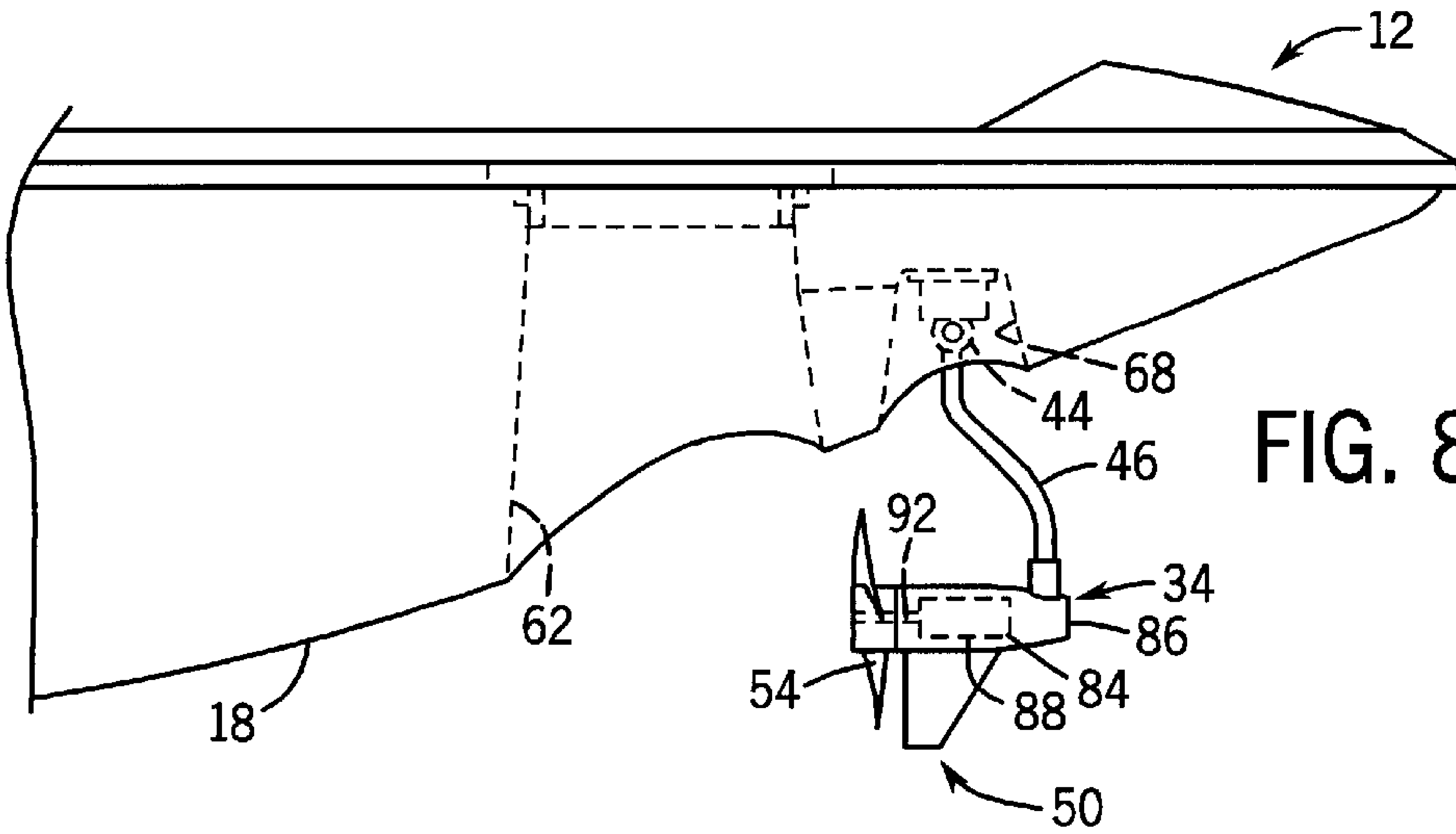


FIG. 8

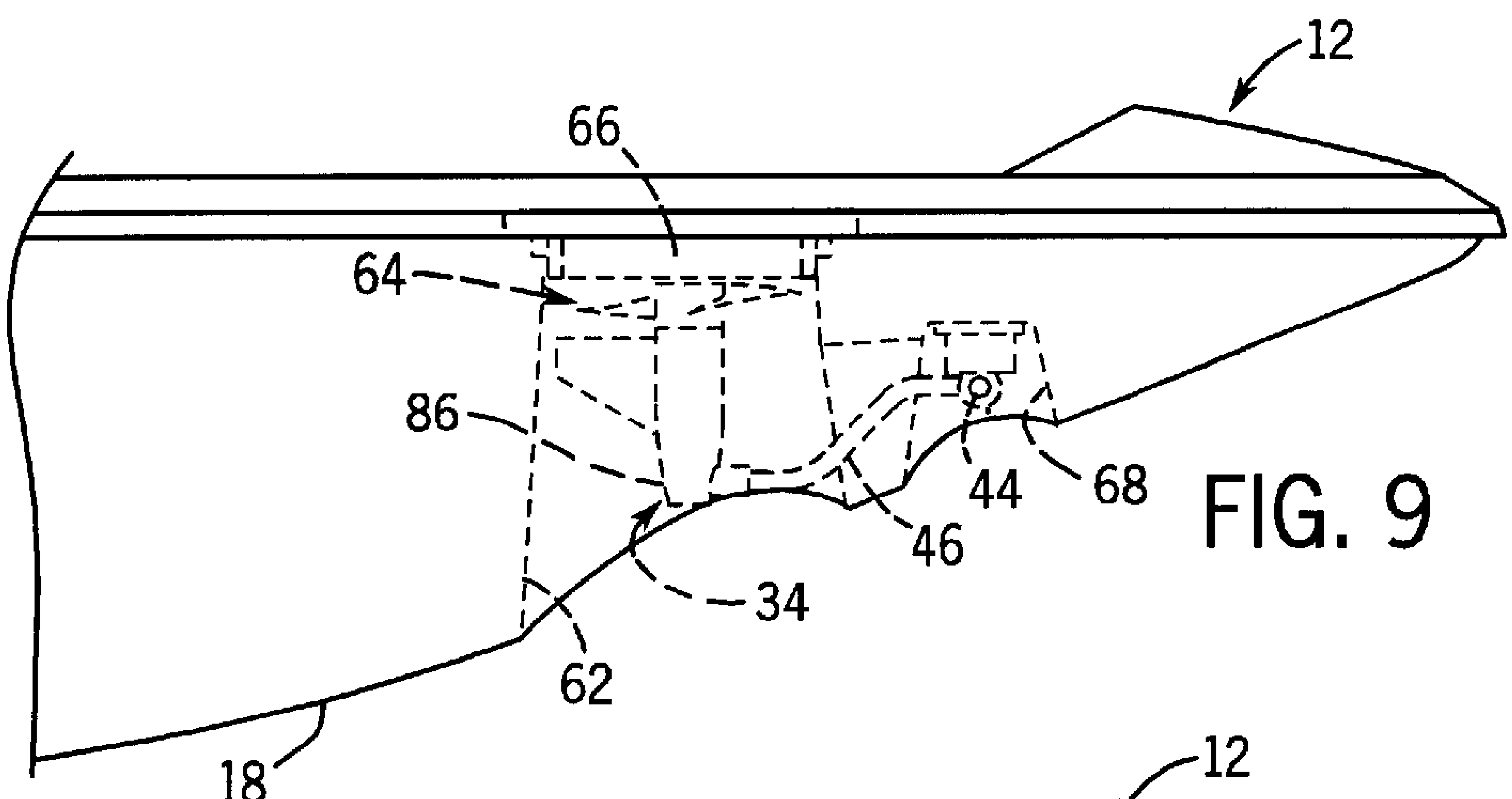


FIG. 9

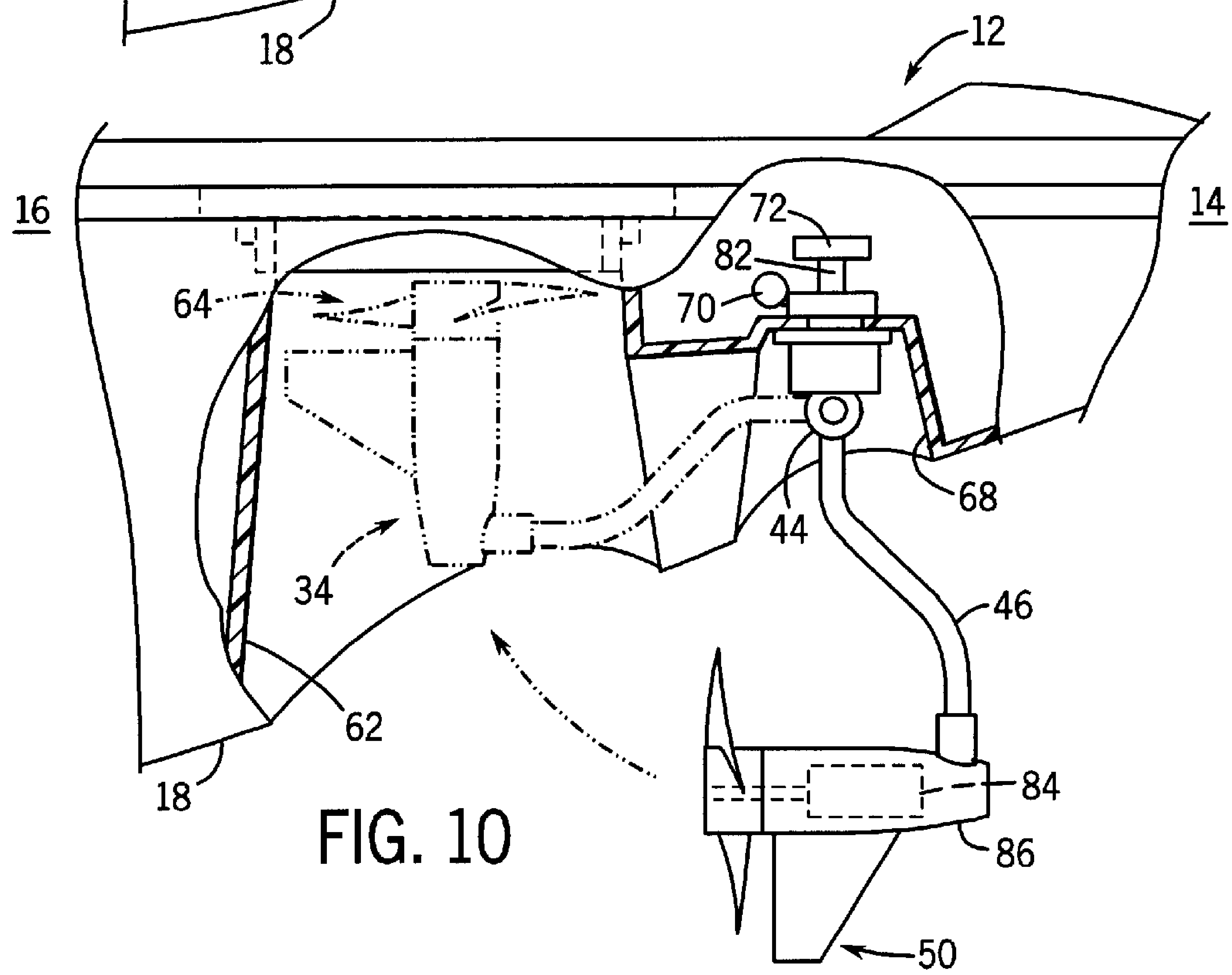


FIG. 10

RETRACTABLE TROLLING MOTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to electric propulsion units for recreational watercraft. More specifically, the present invention relates to propulsion units which mount in a forward area of the watercraft.

2. Description of the Related Art

Recreational watercraft are typically used for a variety of activities such as fishing, cruising, water skiing, and so forth. To move the watercraft across the water, an adequate amount of thrust is necessary depending on the particular activity. The thrust may be provided by a variety of propulsion systems, typically electrically or mechanically powered. Mechanical propulsion systems generally include outboard or inboard/outboard engine-driven propeller systems. In the field of propulsion systems for watercraft, and particularly for pleasure craft, various electrical and mechanical propulsion devices have been proposed and adopted for use. In general, such systems include internal combustion engines drives and electric drives.

Internal combustion engine drives are generally disposed at the rear of a watercraft at a transom, either outboard or inboard. Outboard motors are typically secured to the transom of a boat, while inboard motors have a propeller extending through the transom from an internal combustion engine disposed within a housing of the hull. Both outboard and inboard motors are particularly useful for high-speed and highly responsive navigation of the watercraft. Drawbacks of such drives, however, include their noise levels, exhaust emissions, relative complexity, size and weight.

Electric propulsion systems for pleasure craft are typically referred to as trolling motors or electric outboards. These systems include an electric motor which can be rotated at various speeds to drive a prop. The prop produces a thrust which is directed by proper orientation of the propulsion unit. In conventional trolling motors, for example, a control head may be manually oriented to navigate the boat in a desired direction, or a remote control assembly may be provided for rotating a support tube which holds the propulsion unit submerged during use. While certain relatively minor differences may exist, the term electric outboard is typically employed for the conventional trolling motor design, but with a horsepower range elevated with respect to the conventional trolling motor, such as in excess of 1 horsepower.

While the conventional trolling motor provides quiet and reliable navigation, extremely usefull for certain activities such as fishing, there is considerable room for improvement. For example, conventional trolling motors are typically after-market add-on units designed for mounting on the deck of a watercraft. Such units are typically supported by a mounting structure, a wide range of which may be obtained commercially, which allows for relatively straightforward deployment of the motor to position the propulsion unit below the waterline alongside the deck, and retraction of the unit for storage on the deck. The entire motor and mount, however, generally remain securely fixed to the deck, both during use and storage. The resulting structure is somewhat cumbersome and occupies useful space on the deck, limiting access to the water in the area of the motor mount. Moreover, while much energy and creativity have been invested in boat designs, the aesthetics and aerodynamics of the hull may be somewhat impaired by the trolling motor and mount positioned on the deck, typically adjacent to the bow. Furthermore, conventional trolling motors only provide thrust at a point adjacent to the perimeter of a watercraft, thereby allowing external forces such as wind to force the watercraft out of alignment with the desired direction of movement across the water.

SUMMARY OF THE INVENTION

The present invention provides a propulsion system for a watercraft designed to address these drawbacks. The propulsion system may be an integral part of a watercraft or may be retrofitted to existing designs. The propulsion system is preferably mounted to the hull in a central area, rather than along the perimeter of the watercraft. This frees deck space, and removes the trolling motor typically mounted to the deck. The propulsion system may be used as a primary thrust source, an alternative thrust source, a correctional steering thrust source, or in other specialized applications.

The propulsion system includes a propulsion assembly coupled to a retractable arm, which is pivotable between a stowed position and an operational position. The propulsion assembly may be configured for an inboard or an outboard drive, either electrical or mechanical, and preferably has a prop to provide thrust. The propulsion assembly may also be configured for one or more drive units for pivoting the assembly, and for rotating the assembly to a desired direction.

The propulsion assembly is stowed at a stowed position, in which a portion of the assembly fits within a recessional housing in the hull of the watercraft. The recessional housing may be an integral part of the watercraft, or it may be retrofitted to a particular watercraft. The recessional housing stows the propulsion assembly while non-operational, and may provide access to the assembly for maintenance and cleaning, and may reduce drag.

The propulsion system may also be configured for interconnection with a control system. An exemplary control system may include a control panel with instruments, and a foot pedal for hands-free operation.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

FIG. **1** illustrates a top view of an embodiment of a propulsion system, which is adapted for and disposed in a watercraft;

FIG. **2** illustrates a side view of an embodiment of the propulsion assembly extending outwardly from the hull in an operational position;

FIG. **3** illustrates a side view of an embodiment of the propulsion assembly in a stowed position partially within a recessional housing of the hull;

FIG. **4** illustrates a side view of an embodiment of the propulsion assembly mounted in a recessed area of the hull;

FIG. **5** illustrates a side view of an embodiment of a propulsion assembly having a curved or bent support arm in an operational position;

FIG. **6** illustrates a side view of an embodiment of the propulsion assembly of FIG. **5** in the stowed position, having the retractable arm bent;

FIG. **7** illustrates a somewhat more detailed side view of an embodiment of the propulsion assembly of FIG. **5** mounted in a recessed area;

FIG. **8** illustrates a side view of a further embodiment of a propulsion assembly having a drive motor in a lower unit;

FIG. **9** illustrates a side view of the propulsion assembly of FIG. **8** in the stowed position; and

FIG. **10** illustrates a somewhat more detailed side view of the propulsion assembly of FIG. **8**.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

Turning now to the drawings, FIG. **1** illustrates a top view of a propulsion system **10** adapted for and disposed in a watercraft **12**. The watercraft **12** has a bow **14**, a stem **16**, a hull **18**, and a cabin **20**. The watercraft **12** may also have a rear propulsion unit or motor **22**, mounted either inboard **24** or outboard **26** at a transom **28**. For orientation purposes, FIG. **1** illustrates the watercraft **12** as having a transverse centerline **30** and a longitudinal centerline **32**. The propulsion system **10** preferably includes a propulsion assembly **34** mounted to the hull **18** forward the transverse centerline **30**. The propulsion system **10** may also have a control system **36**, which may include instruments **38** disposed on a console **40** and a foot pedal **42** for hands-free control of the propulsion assembly **34**. These components of the system may be similar to those currently available for control of conventional trolling motors and electric outboards.

FIG. **2** illustrates a side view of an embodiment of the propulsion assembly **34** extending outwardly from the hull **18** in an operational position. The propulsion assembly **34** preferably includes a pivotable joint assembly **44**, and a retractable arm **46** extending outwardly from the pivotable joint assembly **44** to an end **48**. As illustrated, the propulsion assembly **34** is in an operational or thrust position **50** for displacing water to produce thrust for correctively or assistingly steering the watercraft **10**.

A housing **52** is coupled to the retractable arm **46** at the end **48**, and a prop **54** is rotatably coupled to the housing **52** substantially perpendicular to the retractable arm **46**. The prop **54** is drivingly coupled to a power transmission assembly **56** extending through the housing **52** and the retractable arm **46**. The power transmission assembly **56** includes a drive shaft **58** disposed in the retractable arm **46**, a drive shaft **60** disposed in the housing **52**, and a gearbox **61** coupling the drive shafts **58** and **60**. As illustrated, the drive shafts **58** and **60** are rigid. The power transmission assembly **56** also has bearings (not shown in detail) disposed about the drive shafts **58** and **60**. The propulsion system **10**, as illustrated, also includes a recessional housing **62** for stowing the propulsion assembly **34** while not in use.

In this embodiment, the pivotable joint assembly **44** is preferably a sealed gimble assembly. However, a variety of other sealed joint assemblies are contemplated for the pivotable joint **44**. For example, a flexible boot (e.g., rubber) may be used to provide a continuous seal while the retractable arm **46** is pivoted. The pivotable joint assembly **44** may also have a simple pin joint or a ball and socket joint, or even a gearbox for engaging the drive shaft **58**. Furthermore, a flexible shaft assembly may be used for the power transmission assembly **56** to provide flexibility at the pivotable joint assembly **44**. As will be appreciated by those skilled in the art, such flexible shaft assemblies generally include a support tube or sheath and a central drive shaft rotatable within the sheath, both of which are flexible.

FIG. **3** illustrates a side view of an embodiment of the propulsion assembly **34** in a stowed position **64** partially within the recessional housing **62**. The propulsion assembly **34** is retractable into the recessional housing **62** by pivoting about the pivotable joint assembly **44**. A well **66** may be accessible from the cabin **20** (see FIG. **1**) at a location over the recessional housing **62**. In the open position, a hatch (not shown) over well **66** provides access to the propulsion assembly **34**. The propulsion assembly **34** is preferably locked into the stowed position while not in use, either automatically or manually, such as within well **66**. For example, electrical-mechanical locks could be triggered once the propulsion assembly **34** reaches the stowed position **64**, or a user could manually lock the propulsion assembly **34** within the recessional housing **62**. While in the stowed position, the prop **54** is accessible within the well **66**, allowing for maintenance, such as weed removal from the prop **54**.

FIG. **4** illustrates a side view of the propulsion assembly **34** extending from a recessed area **68** of the hull **18**. The propulsion assembly **34** is illustrated in both the thrust position **50**, indicated by solid lines, and the stowed position **64**, indicated by dashed lines. As discussed above, the propulsion assembly **34** is sealingly and pivotably coupled to the hull **18** by the pivotable joint assembly **44**. Outboard of the hull **18**, the prop **54** is drivingly coupled to the power transmission assembly **56**, which extends through the housing **52** and the retractable arm **46**.

On the inboard side of the recessed area **68**, a pivot drive assembly **70** is coupled to the pivotable joint assembly **44** for pivoting the retractably arm **46**. The pivot drive assembly **70** preferably has an electric drive, which is reversible to allow stowage and removal of the propulsion assembly **34**. Alternatively, the pivot drive assembly **70** may be manually driven by a lever and gear device or a pulley assembly (e.g., via coaxial cable arrangements), or other such mechanical devices. In a preferred embodiment, the pivot drive assembly **70** is coupled to, and controlled by, the control system **36** (see FIG. **1**).

To orient the prop **54** to a desired direction of thrust, an angular drive assembly **72** is coupled to the retractable arm **46**. The desired orientation of the prop **54** is preferably attained by rotating the entire retractable arm **46** and the housing **52**. Alternatively, the retractable arm **46** may remain fixed, while the angular drive assembly **72** rotates an inner sleeve extending lengthwise through the retractable arm **46** and coupled to the housing **52**. The angular drive assembly **72** is preferably mounted inboard of the hull **18** adjacent to the pivot drive assembly **70**. An exemplary embodiment of the angular drive assembly **72** includes a reversible electric drive for quietly and smoothly orienting (or steering) the prop **54**. However, the angular drive assembly **72** may be driven manually or otherwise, as described above for the pivot drive assembly **70**. In the illustrated embodiment, the angular drive assembly **72** and the pivot drive assembly **70** are separate units, having separate electric drives. Alternatively, a common electric drive may be used for both the angular drive assembly **72** and the pivot drive assembly **70**. As with the pivot drive assembly **70**, the angular drive assembly **72** is preferably coupled to, and controlled by, the control system **36** (see FIG. **1**).

To drive the prop **54** and produce thrust, a drive assembly **74** is coupled to the power transmission assembly **56**. The drive assembly **74** is preferably mounted inboard of the hull **18** adjacent to the angular drive assembly **72**. An exemplary embodiment of the drive assembly **74** includes a drive motor **76** coupled to a gearbox **78**. The drive motor **76** is preferably an electric drive unit, which may be reversible for reversing thrust and/or ridding the prop **54** of weeds and other debris. Alternatively, the drive motor **76** may be a combustion engine, or any other suitable power source for driving the prop **54**. To control the drive assembly **74**, the control system **36** (see FIG. **1**) is preferably coupled to the drive motor **76**.

While pivoting the propulsion assembly **34** to and from the stowed position **64**, the power transmission assembly **56** may either bend, as with a flexible shaft, or rotate through the pivotable joint. The illustrated embodiment of FIG. **4**, indicates the latter approach, while a flexible shaft may be used to provide some flexibility throughout the pivot. Alternatively, the pivotable joint **44** may provide a mechanism by which the power transmission assembly **56** disengages prior to the pivot towards the stowed position **64**. In this embodiment, the pivotable joint **44** may have a male/female joint between both the angular drive assembly and the retractable arm **46**, and between the drive assembly **74** and the power transmission assembly **56**. The problem of pivoting is thereby solved, and added safety is provided to users who open the hatch above well **66** to examine the prop **54**. Furthermore, the essentially vertical engagement and disengagement of the drive assembly **74** and angular drive assembly **72** provides a more reliable seal at the pivotable joint **44**. By way of example, to maintain a seal between engagement and disengagement, an electric drive may be provided to lift the retractable arm **46** up into a cylindrical opening having annular seals (not shown). Alternatively, a similar member may be driven down over the retractable arm **46**, once the propulsion assembly **34** is in the thrust position **50**.

FIGS. **5–7** illustrate exemplary embodiments of the propulsion assembly **34**, wherein the retractable arm **46** is curved or bent. FIG. **5** illustrates a side view of an embodiment of the propulsion assembly **34** disposed in the thrust position **50**. In this embodiment, the power transmission assembly **56** preferably has a flexible shaft assembly **80** rather than separate rigid components (e.g., the drive shafts **58** and **60** drivingly coupled by the gearbox **61**, as illustrated in FIG. **2**). The retractable arm **46** may be bent to an appropriate curvature for a variety of reasons, such as reducing the resultant force and torque transmitted from the prop **54** to the pivotable joint **44** during operation, tailoring the retractable arm **46** to the shape of the hull **18** and reducing the tendency to become entangled in weeds.

FIG. **6** illustrates a side view of an embodiment of the propulsion assembly **34** disposed in the stowed position **64**. Again, the retractable arm **46** is substantially bent in this embodiment, providing several advantages. One advantage of this embodiment is that the prop **54** is substantially horizontal in the stowed position **64**, as illustrated, providing users with better access to the prop **54** for maintenance and cleaning. Another advantage is that the propulsion assembly **34** may be disposed further into the hull **18**, thereby reducing drag forces in the water.

FIG. **7** illustrates a side view of an embodiment of the propulsion assembly **34** mounted in a recessed area **68** of the hull **18**. Again, the retractable arm **46** is substantially bent. The propulsion assembly **34** is illustrated in both the thrust position **50**, indicated by solid lines, and the stowed position **64**, indicated by dashed lines. Inboard of the hull **18**, the pivot drive assembly **70** is coupled to the pivotable joint **44** for pivoting the propulsion assembly between the thrust position **50** and the stowed position **64**. The angular drive assembly **72** is preferably coupled to the retractable arm **46** by an extension **82**. The extension **82** may be coupled to the retractable arm **46** directly, or the extension **82** may attach to, and rotate, the entire pivotable joint **44**. In this exemplary embodiment, the drive assembly **74** is coupled to the power transmission assembly **56** via the flexible shaft assembly **80**. The flexible shaft assembly **74** preferably extends from the prop **54** to the gearbox **78**, thereby simplifying the connection and adding flexibility at the pivotable joint **44**. Alternatively, the power transmission assembly **56** may be broken into sections, having either rigid shafts or flexible shaft assemblies.

FIGS. **8–10** illustrate embodiments of the propulsion assembly **34**, wherein the retractable arm **46** is again curved or bent, and a drive assembly **84** is disposed in an enlarged housing **86** to incorporate the drive or propulsion motor therein. FIG. **8** illustrates a side view of an embodiment of the propulsion assembly **34** disposed in the thrust position **50**. The drive assembly **84** preferably has an electric drive **88** which transmits torque via a drive shaft **92** coupled to the prop **54**. The retractable arm **46** is preferably bent such that the enlarged housing **86** is substantially centered below the pivotable joint **44**, which may better balance the weight of the propulsion assembly **34**. In a preferred embodiment, the drive assembly **84** is coupled to the control system **36**.

FIG. **9** illustrates a side view of an embodiment of the propulsion assembly **34** disposed in the stowed position **64**. As illustrated, the recessional housing **62** may be slightly enlarged to accompany the enlarged housing **86**. In the stowed position **64**, the enlarged housing **86** and prop **54** are disposed within well **66** for protection, maintenance and cleaning (such as via a hatch within the deck). Also, the curved shape of the retractable arm **46** may be advantageous for pivoting the propulsion assembly **34** into the recessional housing **62**. Again, the curved shape of the retractable arm **46** may also be advantageous for balancing the forces and torques transmitted to the pivotable joint.

FIG. **10** illustrates a more detailed side view of an embodiment of the propulsion assembly **34** mounted in a recessed area **68** of the hull **18**. Again, the retractable arm **46** is substantially bent and the drive assembly **84** is disposed within the enlarged housing **86**. The propulsion assembly **34** is illustrated in both the thrust position **50**, indicated by solid lines, and the stowed position **64**, indicated by dashed lines. Inboard of the hull **18**, the pivot drive assembly **70** is coupled to the pivotable joint **44** for pivoting the propulsion assembly between the thrust position **50** and the stowed position **64**. The angular drive assembly **72** is coupled, directly or indirectly, to the retractable arm **46**. For example, the angular drive assembly **72** and the retractable arm **46** may be interlinked by the extension **82**, the pivotable joint **44** and/or other appropriate linkages. This embodiment is advantageous for many reasons, one of which is that the size and weight of the drive assembly is moved further back towards the stem **16**, providing better balance of the weights in the watercraft and freeing up space towards the bow **14**.

While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

What is claimed is:

1. A propulsion system for a watercraft, the watercraft having a hull, a longitudinal centerline, and a transverse centerline, the system comprising:

a propulsion assembly for displacing water to produce thrust; and

a retractable arm coupled to the propulsion assembly, wherein the retractable arm is configured for pivotable mounting to the hull forward the transverse centerline such that the propulsion assembly is pivotable between a thrust position, and a stowed position within a waterline perimeter of the hull.

2. The propulsion system of claim **1**, further comprising a pivot drive assembly coupled to the retractable arm.

3. The propulsion system of claim **2**, wherein the pivot drive assembly comprises an electric motor.

4. The propulsion system of claim **3**, wherein the electric motor is configured for inboard mounting.

5. The propulsion system of claim **1**, further comprising an angular drive assembly coupled to the propulsion assembly for orienting the propulsion assembly to produce thrust in a desired direction during operation.

6. The propulsion system of claim **5**, wherein the angular drive assembly comprises an electric motor.

7. The propulsion system of claim **6**, wherein the electric motor is configured for inboard mounting.

8. The propulsion system of claim **1**, further comprising a power transmission assembly configured for transmitting a torque from a drive assembly to the propulsion assembly.

9. The propulsion system of claim **8**, wherein the retractable arm is hollow and the power transmission assembly extends lengthwise through the retractable arm.

10. The propulsion system of claim **9**, wherein the power transmission assembly further comprises a support tube in which a drive shaft is rotatably disposed.

11. The propulsion system of claim **10**, wherein the drive shaft is rigid.

12. The propulsion system of claim **10**, wherein the drive shaft is flexible.

13. The propulsion system of claim **1**, wherein the propulsion assembly comprises a reversible electric drive motor.

14. The propulsion system of claim **1**, wherein the propulsion assembly comprises a housing having a gear assembly configured for receiving a drive shaft and for transmitting torque to a prop.

15. The propulsion system of claim **1**, wherein the propulsion assembly comprises a housing having a flexible shaft assembly configured for transmitting torque from a drive shaft to a prop.

16. The propulsion system of claim **1**, wherein the retractable arm is configured for a pivotable mounting to the hull along the longitudinal centerline.

17. The propulsion system of claim **1**, further comprising a recessional housing configured to sealingly mount to the hull forward the transverse centerline, wherein the recessional housing is adapted for recessionally securing the propulsion assembly to reduce drag when not in use.

18. A watercraft comprising:

a hull having a recessional housing forward a transverse centerline of the watercraft;

a propulsion assembly for displacing water to produce thrust; and

an arm pivotably coupling the propulsion assembly to the hull, wherein the arm is configured to pivot the propulsion assembly between a thrust position and a stowed position within the recessional housing.

19. The propulsion system of claim **18**, further comprising a pivot drive assembly coupled to the arm.

20. The propulsion system of claim **18**, further comprising an angular drive assembly coupled to the propulsion assembly for orienting the propulsion assembly to produce thrust in a desired direction during operation.

21. The propulsion system of claim **18**, further comprising a power transmission assembly configured for transmitting a torque from a drive assembly to the propulsion assembly.

22. The propulsion system of claim **21**, wherein the arm is hollow and the power transmission assembly extends lengthwise through the arm.

23. The propulsion system of claim **22**, wherein the power transmission assembly comprises a rigid drive shaft rotatably supported by a bearing assembly.

24. The propulsion system of claim **22**, wherein the power transmission assembly comprises a flexible shaft assembly.

25. The propulsion system of claim **18**, wherein the propulsion assembly comprises a housing having a gear assembly coupled to the power transmission assembly, wherein the gear assembly is adapted for transmitting the torque to a prop.

26. A method of displacing a watercraft, the watercraft having a hull and a transverse centerline, the method comprising:

pivoting a retractable propulsion assembly mounted forward of the transverse centerline from a stowed position to an operational position, wherein in the stowed position at least a portion of the propulsion system is received within a recessional housing of the hull, and wherein the step of pivoting includes removal of the portion of the propulsion system from the recessional housing; and

powering an electric drive motor of the propulsion assembly to drive a prop and thereby to produce a thrust in a desired direction.

27. The method of claim **26**, further comprising rotating the propulsion assembly to a desired orientation to produce the thrust in the desired direction.

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